

CLAIMS

1. A color display element using a medium having optical properties modulated by an external modulation means,

5 characterized in that said medium has a brightness modulation range where a brightness is changed by said modulation means and a color modulation range where a color is changed by said modulation means,

10 the color display element has a unit pixel comprised of a plurality of sub-pixels including a first sub-pixel and a second sub-pixel having a color filter, and

said modulation means gives modulation of said
15 color modulation range to the first sub-pixel to display colors within the color modulation range, and gives modulation of said brightness modulation range to the second sub-pixel to display brightness of the color of said color filter within the brightness
20 modulation range, whereby provides a color display.

2. The color display element according to claim 1, wherein said second sub-pixel has a green color filter.

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3. The color display element according to claim 1, wherein a modulation range of said first sub-pixel

is comprised of the color modulation range which is chromatic color.

4. The color display element according to claim
5 3, wherein a modulation range of said first sub-pixel includes red and blue colors and an intermediate color between the red and blue colors.

5. The color display element according to claim
10 1, wherein said modulation means further gives modulation of the brightness modulation range to said first sub-pixel.

6. The color display element according to claim
15 1, wherein said first sub-pixel is comprised of sub-pixels having different areas, and a halftone is displayed with the area of sub-pixels showing a color.

7. The color display element according to claim
20 1, wherein said second sub-pixel has at least a green color filter and said first sub-pixel has a color filter of color complementary to the green color.

8. The color display element according to claim
25 7, wherein said modulation means further gives a modulation of the brightness modulation range to said first sub-pixel.

9. The color display element according to claim 8, wherein said second sub-pixel is comprised of a plurality of sub-pixels, one of the plurality of sub-pixels has a green color filter, and the others have
5 color filters of at least one of red and blue colors.

10. The color display element according to claim 9, wherein said first sub-pixel is comprised of sub-pixels having different areas, and a halftone is
10 displayed with the area of sub-pixels showing a color.

11. The color display element according to claim 10, wherein the areas of said sub-pixels having color filters of at least one of red and blue colors
15 are substantially equal to or smaller than the area of the smallest sub-pixel of sub-pixels comprising said first sub-pixel.

12. The color display element according to claim 1, characterized in that a plurality of metal
20 films are placed at least on a substrate, the color display element has a capability of changing a tone of interference color by modulating a gap distance being a thickness of air as a medium for the metal
25 films and the substrate, and at least one of said plurality of sub-pixels is comprised of a first sub-pixel capable of providing color display based on a

change in color according to a change in interference color associated with a change in gap distance, and a second sub-pixel having a color filter layer.

5 13. The color display element according to claim 1, characterized in that a plurality of particles as a medium are moved by application of a voltage, and

 at least one of said plurality of sub-pixels is
10 comprised of a first sub-pixel including at least two drive electrodes and at least two types of particles having mutually different particle migration characteristics and colors, and a second sub-pixel having a color filter layer.

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 14. The color display element according to claim 13, characterized in that said first sub-pixel comprises two display electrodes situated in such a manner that one is almost superimposed on another
20 when viewed by an observer, two collect electrodes, and two types of particles having mutually different particle migration characteristics and colors and at least one of which is pervious to light, and includes a drive means capable of forming a state in which the
25 two types of particles all collect on the collect electrodes or are all placed on the display electrodes, or a state in which one type of particles

are placed on the display electrodes and the other type of particles collect on the collect electrodes, or an intermediate state.

5 15. The color display element according to claim 14, characterized in that the combination of colors of the two types of particles in said first sub-pixel is a combination of blue and red.

10 16. The color display element according to claim 14, wherein the color of particles for use in said second sub-pixel is black.

 17. A color liquid crystal display element
15 using a liquid crystal layer having optical properties changed by application of a voltage, characterized in that said color display element comprises at least one polarizing plate, a pair of substrates provided with electrodes and so
20 situated as to face each other, and a liquid crystal layer placed between the substrates, and has a capability of modulating incident polarized light into a desired polarized state by retardation of the liquid crystal layer,

25 a unit pixel of said color display element is comprised of a plurality of sub-pixels, and said plurality of sub-pixels include a first

sub-pixel changing retardation of the liquid crystal layer by application of a voltage to display a chromatic color, and a second sub-pixel having a color filter, and changing retardation in an
5 achromatic area brightness modulation range by a voltage to display a color of the color filter.

18. The color liquid crystal display element according to claim 17, wherein liquid crystal
10 molecules of said liquid crystal are almost perpendicularly oriented to the substrates when no voltage is applied, and incline against the almost perpendicular orientation when a voltage is applied, to change the retardation.

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19. The color liquid crystal display element according to claim 17, wherein the liquid crystal molecule changes the orientation in a range of state between a bend orientation and the almost
20 perpendicular orientation through an application of voltage, to change the retardation.

20. The color liquid crystal display element according to claim 17, characterized in that a cell
25 thickness d_1 in said first sub-pixel and a cell thickness d_2 in said second sub-pixel satisfy the relation of $d_1 > d_2$.

21. The color liquid crystal display element according to claim 17, wherein said first sub-pixel and said second sub-pixel have a light reflection means to form a reflection display area, and said
5 unit pixel further includes a transmission display area comprised of a third sub-pixel, through which at least part of light from the back surface passes.

22. The color liquid crystal display element
10 according to claim 21, wherein said third sub-pixel is divided into three sub-pixels provided with red, green and blue color filters, respectively.

23. The color liquid crystal display element
15 according to claim 22, wherein said third sub-pixel changes retardation in an achromatic area with a voltage to display the color of each color filter.

24. A method for providing color display using
20 a color display element,

characterized in that a color display element is formed using a medium having a color modulation range where a color is modulated by external modulation means, and a brightness modulation range
25 where a bright ness of a color is modulated by said modulation means,

a unit pixel of said color display element is

divided into a first sub-pixel and a second sub-pixel having a color filter, and

said first sub-pixel is made to display chromatic colors within said color modulation range, and said second sub-pixel is made to display a brightness of a color of said color filter within the brightness modulation range, whereby color display is provided.

25. The method according to claim 24, wherein the second sub-pixel has a green color filter.

26. The method according to claim 24, wherein a color display device in which the second sub-pixel has at least a green color filter and the first sub-pixel has a color filter of color complementary to the green color is used; a modulation of the brightness modulation range is given to the second sub-pixel to change a brightness of the green color; a modulation of the color modulation range is given to the first sub-pixel to display a chromatic color; and a modulation of the brightness modulation range is given, to change a brightness of the color complementary to the green color.

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27. The method according to claim 26, wherein said first sub-pixel is divided into a plurality of

sub-pixels having different areas to make the sub-pixels display the chromatic color and to make the others carry out the displaying of changing the brightness, whereby a halftone of said color
5 complementary to the green color is displayed.

28. The method according to claim 27, wherein said second sub-pixel is divided into a plurality of sub-pixels, one of the plurality of sub-pixels is
10 provided with a green color filter, the others are provided with color filters of at least one of red and blue colors, and a modulation of the brightness modulation range is given to each of the second sub-pixels to cause a change in brightness, whereby said
15 green color and a halftone of said color complementary to the green color are continuously displayed.

29. The method according to claim 28, wherein
20 said modulation is performed so that the highest brightness of said sub-pixels provided with color filters of at least one of red and blue colors is almost equal to the brightness displayed by the smallest sub-pixel of sub-pixels comprising said
25 first sub-pixel.